

ENGINEERING DRAWINGS

I. Introduction

The great advances in computing power and the proliferation of computer-aided design and drafting software have gone a long way towards eliminating the use of engineering drawings as the primary means of communicating the details of a design. Nevertheless, engineering drawings still serve a key role in documenting the design - only now they are supplemented by solid models and other product information that is stored digitally. As the old saying goes, “A picture is worth a thousand words,” and a 2-D representation of some aspect of a design, printed on paper, is still a viable and useful means of communicating information. Once printed, the drawing doesn’t rely on the availability of specialized computer hardware or software to be useful. All that is required is that the users understand how to interpret and visualize what is being represented on the drawing.

Many standards have been developed to specify the ways in which three-dimensional objects are presented in two-dimensional drawings so that the object and all of its features are defined unambiguously. Before the advent of computer-aided design and drafting, engineering students usually took several courses in mechanical drawing in which they learned the skills necessary to produce accurate drawings of machine parts and structures. These skills are not as essential today since the CAD packages can usually generate appropriate drawings much more rapidly than they can be produced by hand. Revisions and edits are just a few mouse clicks away. Nevertheless, it is necessary to be able to interpret the drawings and to be able to form a picture in ones mind of the three-dimensional object that is presented on a sheet of paper. The objectives of this lesson are to familiarize you with the more common ways to present engineering drawings and to explain some guidelines for placing dimensions on a drawing.

II. Multiview Projection

An isometric drawing of an object as shown in Figure 1 is a common way to give a pictorial representation of a 3-D object. A drawback of the isometric drawing is that practically none of the features of the object are shown as true size. It is difficult to extract quantitative information about the features of an object from an isometric drawing. Three-dimensional objects are most commonly represented in 2-D engineering drawings by use of multiview projections. In this technique, the object is presented as it would appear when viewed by an observer looking at the object from several different viewing angles. The six standard directions from which to view an object are the front, rear, right side, left side, top and bottom views as shown in Figure 1. Three of these views show similar information to the other three, just from the opposite direction. In order to make interpretation of drawings easier, these views are arranged in a standard way on the drawing as shown in Figure 2.

Each view is constructed by imagining that you are viewing the object through a sheet of glass, perpendicular to your line of sight. The outline of the edges of object are projected onto the glass using parallel rays which are orthogonal to the sheet of glass. This method of projection is called *orthographic projection*. It is common practice to orient the object so that its principal

features are parallel and perpendicular to the viewing planes. The standard layout of the principal views can be best understood by imagining that the object to be drawn is placed inside a glass box with its principal features aligned with the faces of the box. The object is viewed through each face of the box and the outline of the object is projected onto the faces of the box as shown in Figure 3. Once the views have been established, the box is unfolded, as shown in Figures 4 and 5, so that all of the views lie in a single plane. Notice that the corresponding features appearing in adjacent views are always aligned between the views and that the scale of each view is the same. This is a consequence of the procedure used to unfold the glass box and it makes it easier for someone to visualize the three-dimensional object by preserving the relationships between the various views.

Each view shows two of the three principal dimensions of the object, *height*, *width* and *depth*. The front and rear views always shows the height and width, the top and bottom views show the depth and width and the right and left side views show the height and depth. The specific features of the object that correspond to the height, depth and width are established by the way in which the object is oriented in the box. In Figure 5 you may notice that some lines are solid and other lines are broken. Visible edges in a view are shown with solid lines. The hidden edges of features which are not directly visible in the view are shown with broken lines.

For many objects, the bottom, rear and left side views do not add any essential information needed to visualize the object. It is common practice to limit the number of views shown to only the necessary views. When three views are sufficient, the front, top and right side views are preferred. When two views are all that is required, any two of the top, front or right side views may be used, whichever give the best representation of the object. In any case, the views shall always be aligned and to the same scale to show the relationship among the various features as they appear in each view.

Planar surfaces may be parallel, inclined or oblique to the viewing plane. A planar surface that is parallel to the viewing plane appears as true size in that view and appears as an edge in the two perpendicular views. An inclined surface is a surface that is perpendicular to one of the planes of projection and appears on edge in that view. It is inclined to the other two views and does not appear true size in any of the principal views. An oblique surface is a surface that is not parallel to any of the principal views. Therefore, it always appears foreshortened (smaller than actual size) in the standard views. Examples of normal, inclined and oblique surfaces are shown in Figure 6.

Auxiliary Views - It is often desirable to show features located on inclined or oblique surfaces as true size. In order to do this, an auxiliary view must be established in a plane parallel to the inclined or oblique surface. The auxiliary view should be aligned with one of the other principal views if possible; if not, special viewing-plane lines are used to indicate the viewing direction and the auxiliary view is identified with a label corresponding to the viewing plane. An example of an auxiliary view is shown in Figure 7.

Section Views - The most important features of some objects may not be visible from one or more of the principal planes, except as hidden surfaces or edges. In these cases the hidden lines may not provide the best description of the internal features. A section view is typically used in this situation as shown in Figure 8. A section view is a cut-away of the object that is made by passing an imaginary cutting plane through the object and then drawing the section view as if you were looking at the surfaces revealed by the cut. This makes the internal features visible. Note that the section is aligned with the original part and that the features are related between the two views. Material that has been cut by the cutting plane is indicated by section lines, a series of light parallel lines, usually drawn at a 45 degree angle. The style of the section lines can be used to identify the type of material that is being cut.

Acknowledgement - The images used in Figures 1,3-5 and 7-8 were reproduced from the text, **Modern Graphics Communication**, by Giesecke, F.E, et al., Prentice-Hall, Upper Saddle River, 1998.

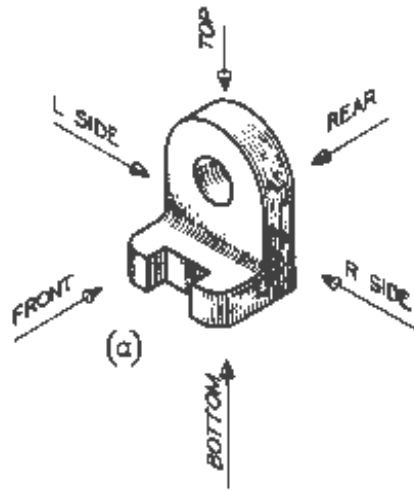


Figure 1 An isometric drawing and the standard viewing angles of an object.

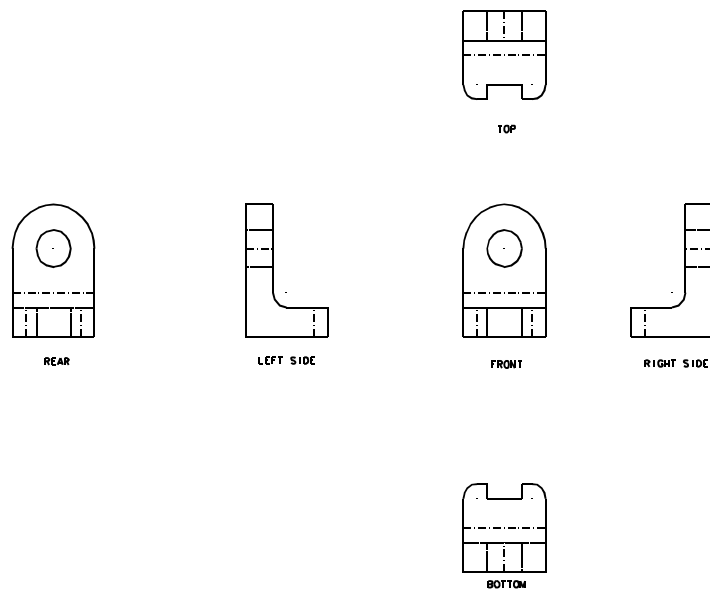


Figure 2 Standard arrangement of views

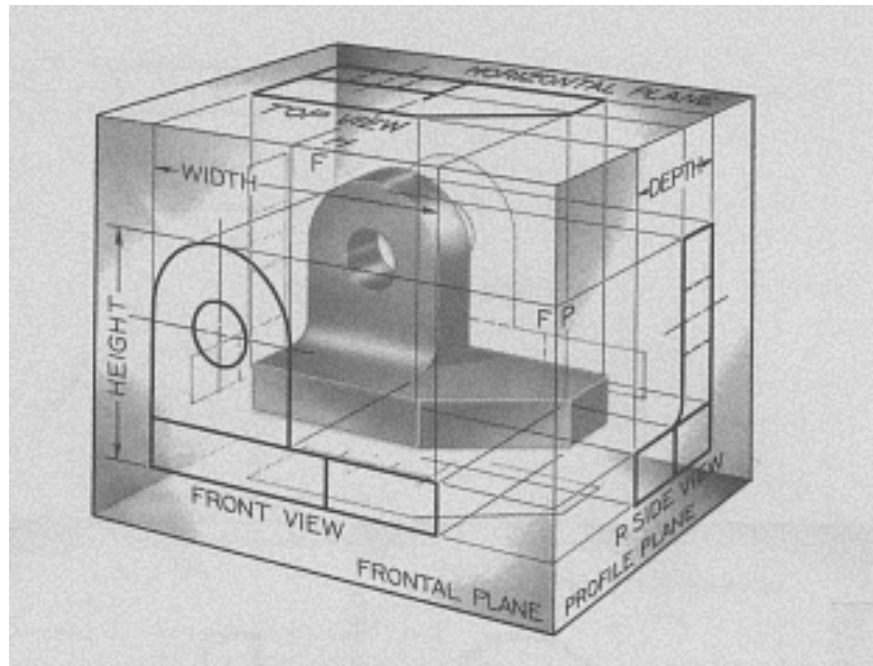


Figure 3 An object to be drawn is positioned inside the glass box

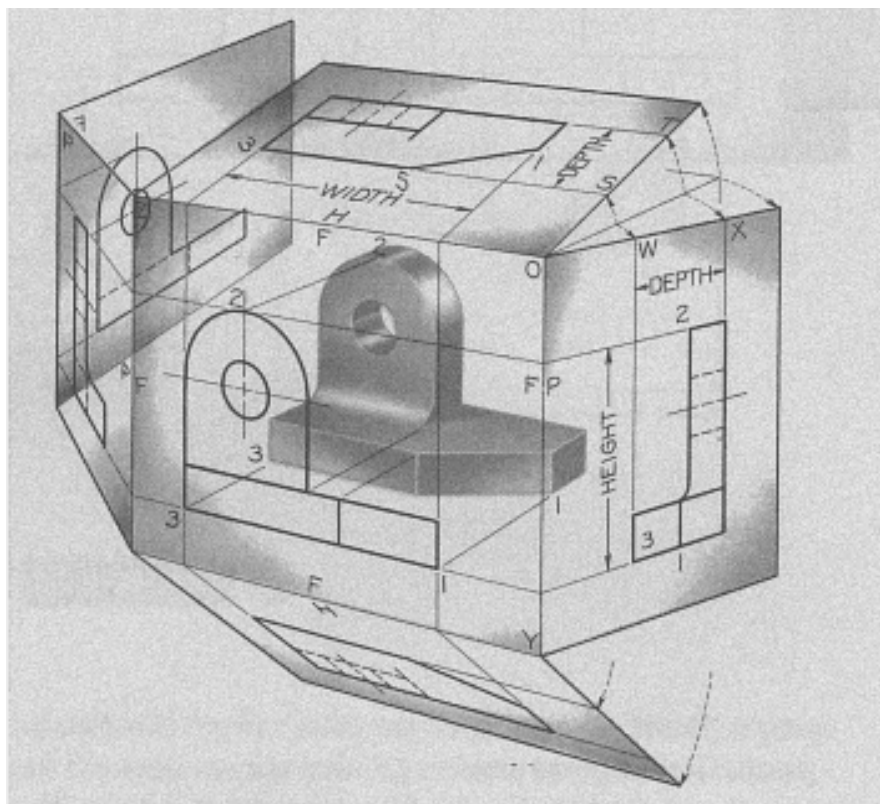


Figure 4 The process of unfolding the glass box.

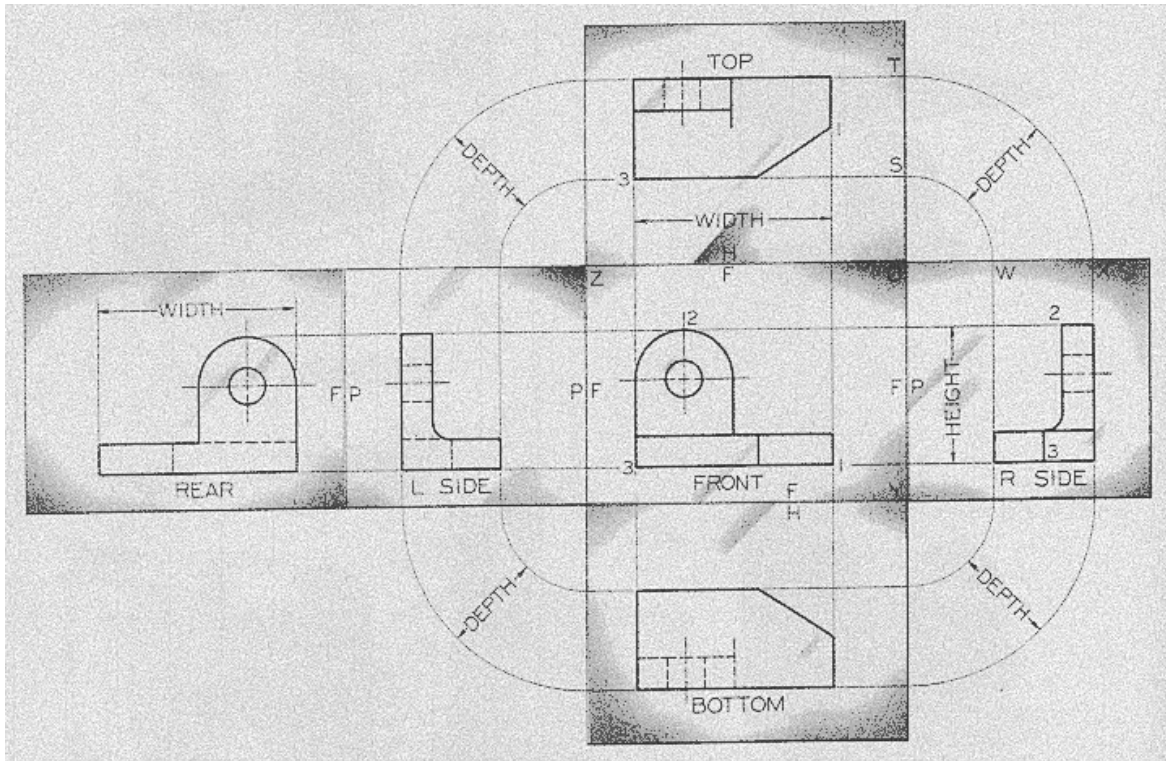


Figure 5 The arrangement of the six standard views used in orthographic projection.

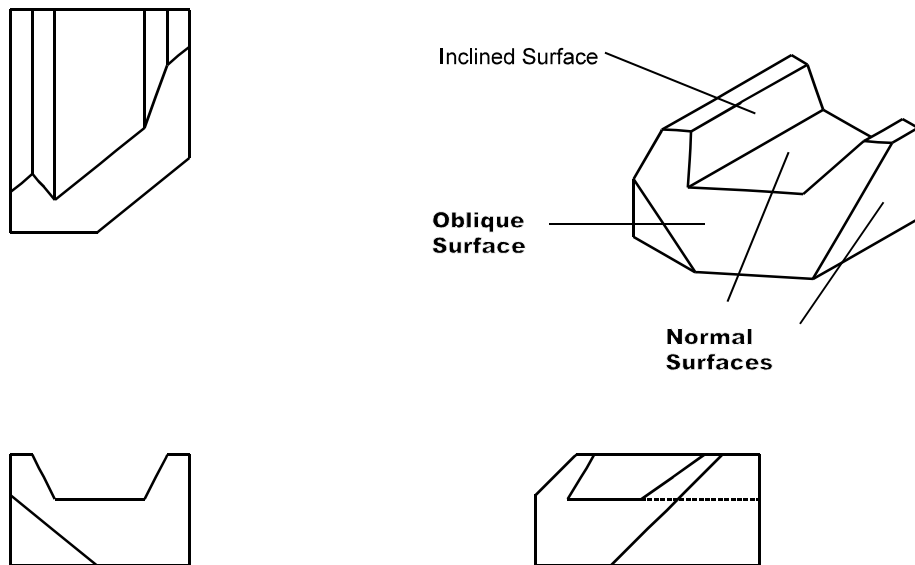


Figure 6 Examples of normal, inclined and oblique surfaces.

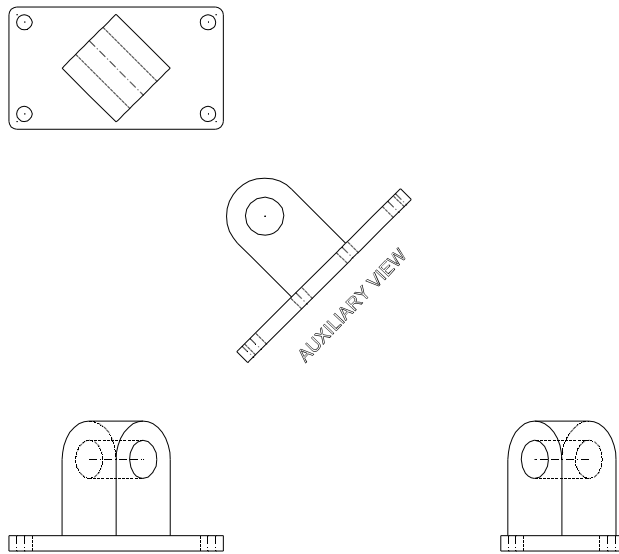


Figure 7 Auxiliary views are used to show features located on inclined and oblique surfaces as true size

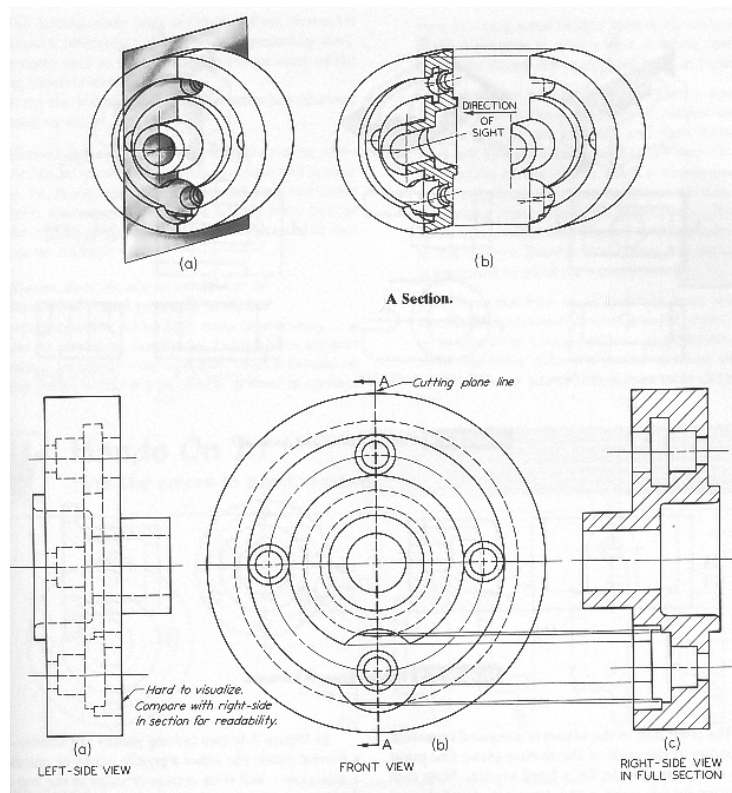


Figure 8 Section views are used to show the details of internal features